1. INTRODUCTION

On behalf of the U.S. Environmental Protection Agency (EPA), Region 10, Parametrix has prepared this Construction Oversight Report to document oversight activities of the non-time critical early removal action conducted at the Northwest Natural (NW Natural) facility (referred to as the “GASCO site”) in northwest Portland, Oregon. The GASCO site is located along the west bank of the Willamette River within the Portland Harbor Superfund Site at approximately river mile 6.3. The vicinity of the site is shown on Figure 1. The project site is shown on Figure 2.

This Construction Oversight Report has been prepared to document the activities conducted during the early removal action and includes a summary of oversight methods, field observations, and photographic documentation. In addition, this report includes an evaluation of selected data and other site information to provide an understanding of the issues identified by the EPA project team, which can be used to guide future early removal actions at the GASCO site or other sites within the Portland Harbor Superfund Site. The EPA project team includes representatives of the EPA, Oregon Department of Environmental Quality (DEQ), Oregon Department of Fish and Wildlife (ODFW), National Marine Fisheries Service (NMFS), Tribal representatives, and Parametrix.

Northwest Natural’s environmental consultant, Anchor Environmental, LLC (Anchor), prepared a Draft Removal Action Completion Report (RACR) (Anchor Environmental 2006a) which included a summary of the removal action activities and a presentation of project-related data. The EPA project team reviewed the Draft RACR and provided comments in a letter dated February 13, 2006 (EPA 2006). In general, many of the comments were related to insufficient evaluation of the project data. NW Natural addressed the comments and prepared the Final RACR (Anchor 2006b) for EPA project team review. Although the revised RACR included additional evaluation of the site data, the EPA project team indicated that further evaluation was necessary to address specific issues identified during the removal action, which can be used in a “lessons learned” approach in guiding future early removal actions. Therefore, EPA contracted Parametrix to address the missing information and include it in this report.

It is expected that this Construction Oversight Report will be used as a complimentary document to the RACR to gain an understanding of project issues. This report does not reproduce all of the data and evaluation included in the RACR. Rather, this Construction Oversight Report focuses on the specific issues identified by the EPA project team as critical components to the success of future early actions and includes only those evaluations identified as missing from the RACR or not adequately addressed in the RACR. Other documents that are related to the GASCO early removal action may provide important background information and a more complete understanding of the site action to date. These documents include the Engineering Evaluation/Cost Analysis (Anchor 2005a), the Removal Action Project Plan (Anchor 2005b), the EPA Action Memorandum (EPA 2005a) and Clean Water Act 401 Water Quality Certification (EPA 2005b), and the Biological Opinion (NMFS 2005), and can be downloaded from:

http://yosemite.epa.gov/r10/cleanup.nsf/6d62f9a16e249d7888256db4005fa293/30e48bd949cf7508882571420008affd!OpenDocument

1.1 PROJECT BACKGROUND

The GASCO site consists of approximately 35 acres and is located along the west bank of the Willamette River, south of the St. Johns Bridge at approximately river mile 6.3. The site, currently owned by the Northwest Natural Gas Company, the assumed name of the Portland Gas and Coke Company (GASCO), is located adjacent to the Wacker Siltronic and U.S. Army Corps of Engineers U.S. Moorings facilities (Figure 1). The project site is shown on Figure 2.

The EPA identification number for the GASCO site is CERCLIS - OR027734359. The site is within the boundaries of the Initial Study Area of the Portland Harbor Superfund Site, which was listed on the National Priorities List (NPL), pursuant to Section 105 of CERCLA, 42 U.S.C § 9605 on December 1, 2000. NW Natural is one of ten parties that signed a consent order for remedial investigation/feasibility study (RI/FS) activities with EPA in September 2001.

The GASCO site is the location of a former manufactured gas plant that deposited tar refining wastes into upland retention areas during the early 1900s. The waste material, by way of an onsite stream channel, was also deposited in low lying areas of the site and along the banks of the Willamette River. By the time the plant was shut down in 1956, an estimated 30,000 cubic yards of waste material had accumulated in the upland ponds, which were buried under 10 feet of fill in 1973. Remedial investigations conducted at the site confirmed the presence of tar to depths of approximately 70 feet and tar wastes extending into the river sediments. Sediment samples were found to contain high concentrations of polynuclear aromatic hydrocarbons (PAHs), benzene, toluene, ethylbenzene, and xylenes (BTEX), and cyanide. A visible tar body, which contains the highest concentrations of total PAHs (tPAHs), is located just east of the dock area along the GASCO shoreline (Figure 2).

NW Natural entered into an Administrative Order on Consent (AOC) with the EPA in April 2004 to perform a time-critical removal action of the tar body. Subsequently, NW Natural prepared a Removal Action Work Plan (RAWP) in August 2004 to outline the scope and objectives of the removal action. Planning and preliminary design of the removal action was initiated in May 2004 and as part of this process, NW Natural conducted a removal action characterization of the tar body in July 2004. The characterization involved the collection of subsurface cores within the removal area in order to:

- Establish the lateral and vertical extents and the physical characteristics of the tar body;
- Estimate elutriate concentrations in the nearby water column that may occur during the removal action;
- Profile the contaminated materials to be removed to determine disposal options; and
- Determine the chemical and physical characteristics of the sediments residing within and beneath the visible contaminated strata.

Planning and preliminary design of the removal action continued through November 2004 when NW Natural submitted a Draft Removal Action Project Plan (RAPP) that further outlined the scope, means and methods of the removal action based on data obtained during the July 2004 characterization effort. The proposed method for removal of the tar body presented in the Draft RAPP included conventional dredging with the use of in-water permeable and impermeable silt curtains surrounding the removal area.

Upon review of the RAPP, the EPA project team indicated concerns relating to the use of silt curtains as the primary containment method and indicated that sheet pile containment should be evaluated. As a result of this dispute, and as required by CERCLA for actions taking greater than 1 year, the EPA required NW Natural to prepare an Engineering Evaluation/Cost Analysis (EE/CA) to evaluate the containment alternatives. The evaluation in the EE/CA indicated that the silt curtain containment (a revised design and more robust system than initially presented in the Draft RAPP) would meet the project objectives and primary criteria evaluated in the EE/CA. NW Natural subsequently submitted the EPA-approved EE/CA in May 2005 for public review. Following solicitation of public comment on the Draft EE/CA, the proposed removal action was approved by the EPA in the Action Memorandum (EPA 2005a). The Final RAPP was submitted to the EPA in July 2005 and the removal action was implemented in August 2005.

In general, project documentation and planning was adequate to complete the removal action and consistent with other EPA projects of similar scope. All project design documents were reviewed and approved by the EPA project team. However, several components of the design (i.e. the silt curtain containment system and impacts to water quality during dredging) were based on significant assumptions and/or modeled results. As discussed in Section 3.0, additional information and/or pilot scale exercises may have resulted in less design shortcomings. However, it should be noted that due to site-specific and complex conditions, some projects cannot be completely understood prior to initiating an action.

The GASCO removal action is considered an "early action" because it is being conducted before the RI and record of decision (ROD) are completed for the site. Therefore, it is not considered a final cleanup remedy for the GASCO site.

1.2 REMOVAL ACTION SUMMARY

The scope and nature of the GASCO removal action is outlined in the RAPP (Anchor 2005b). Per the Statement of Work (Appendix 3 to the AOC), the final project design presented in the RAPP includes: 1) a presentation of all sampling results, quality assurance reviews, and other data evaluations, and 2) various plans to support the implementation of the removal action. The RAPP included the following appended documents:

- Transportation and Disposal Plan
- Construction Health and Safety Plan
- Construction Quality Assurance Plan
- Construction Water/Sediment Monitoring Plan
- Removal Action Environmental Protection Plan
- Monitoring and Reporting Plan

As detailed in the Final RAPP, the project included the removal of approximately 15,000 yards of contaminated tar material. The volume of contaminated material (referred to as the "dredge prism") was approved by EPA during the project planning stages. In general, the removal action involved the use of a derrick-mounted dredging crane, 15 cubic yard closed cable arm bucket and/or 8 cubic yard clamshell bucket, and associated supporting barges. The dredged sediment was amended with drying agent, loaded onto barges, and transported to the offloading facility at the Port of Morrow in Boardman, Oregon. The dredged sediment was then transferred to trucks and hauled to the Chemical Waste Management Northwest Subtitle C landfill in Arlington, Oregon.

The removal action was designed to proceed in two stages, the first occurring within an inner removal area (near shore) and the second in an outer removal area (river-ward). The inner and outer removal areas and equipment configurations are shown on Figures 3 and 4, respectively.

The inner containment area mechanism was comprised of full-length silt curtains (water surface to river bottom), with impermeable curtains used along the portion of the containment parallel to the river and permeable curtain used along the “legs” of the containment, perpendicular to the river. The outer containment mechanism utilized a partial length impermeable silt curtain suspended from the surface to approximately 2-feet above the river bottom. A bed-load baffle was anchored to the river bottom extending upward into the water column. Another curtain was located along the outer edge of the project area and was comprised of an oil boom with a 2-foot impermeable skirt hanging downward. Oil sorbent booms were situated throughout the project area, along the perimeters of both containment areas and in areas from where tar sheen either emanated (shore edge) or accumulated. Detailed specifications of the containment barriers are presented in the RACR (Anchor 2006b).

2. REMOVAL ACTION OVERSIGHT

This section presents a brief summary of the methods and observations made during oversight of the removal action. Critical components and the associated issues encountered during the removal action are discussed in Section 3.0.

2.1 METHODS

At the request of EPA, Parametrix provided daily oversight of the removal action throughout the duration of the project. Parametrix initiated daily oversight starting on August 22, 2005 and continued through October 31, 2005. In general, Parametrix personnel were on-site during all site operations. However, some events, including mobilization/demobilization, maintenance conducted after hours, and other non-critical components of the project were not directly observed. Oversight generally involved performing a physical inspection of the site every morning and evening, and observing all site activities throughout the day, including direct (on boat) observation of water quality sampling conducted offshore. Parametrix field personnel routinely interacted with NW Natural, Anchor, and its' subcontractors to implement EPA field directives or to rectify issues observed throughout the project. Progress of the project and details of site activities were continually reported by field personnel to the Parametrix project manager. An e-mail progress summary and photograph log of site activities were submitted to the EPA project team on a daily basis. Additionally, teleconferences with the EPA project team, as well as NW Natural and its' subcontractors, were conducted on an as needed basis to discuss ongoing issues or decisions during the project.

Parametrix personnel also provided oversight of the transfer facility operation at the Port of Morrow in Boardman, Oregon. A total of six visits (some including several days) were conducted. During these visits, full-time daily observations were conducted including a physical inspection of the site every morning and evening, and observing all site activities throughout the day, including direct (on boat) observation of water quality sampling conducted offshore. The sediment disposal location, Chemical Waste Management Northwest facility in Arlington, Oregon, was also visited once by Parametrix personnel, who were accompanied by the Chemical Waste Management project manager.

Documentation of oversight activities include field notes, daily e-mail progress reports to the EPA project team, and photographs taken throughout the project. Copies of the field notes and daily e-mail project updates are included as Appendix A and Appendix B, respectively. Photographs taken throughout the project, which are organized by each day, are included on the compact disc in Appendix C.

2.2 GENERAL OBSERVATIONS

A detailed description of the removal action activities is included in the RACR. Documentation of the oversight activities and observations are included in Appendices A through C in this report. A brief summary of the general observations of the removal action is presented below.

2.2.1 Schedule

A project kick-off meeting was held on August 22, 2005, which was attended by representatives of NW Natural, Anchor, construction subcontractors (Sevenson Environmental Services, Hickey Marine, Tidewater, Northwest Underwater Construction), DEQ, and Parametrix. The removal action field activities were initiated on August 24, 2005. Initial activities included mobilization, site preparation, and installation of the containment system (silt curtains and bubble curtain).

Dredging within the inner removal area was initiated on September 7, 2005 and continued through October 9, 2005. Concurrent with the last days of dredging the inner removal area, the contractor installed the outer containment system. After a final bathymetry survey was approved for the inner removal area, dredging of the outer removal area was initiated on October 12, 2005 and proceeded until October 19, 2005. A final bathymetry survey was completed and approved by EPA on October 20, 2005. Placement of capping material then proceeded until October 30, 2005. Demobilization activities proceeded from October 30, 2005 through November 4, 2005.

Due to a number of work shutdowns and delays, which occurred due to the discovery of dead fish in the containment area and exceedances of water quality criteria outside the containment area, as well as a shortage of available transport barges, the removal action generally proceeded behind schedule during the initial portion of the project. Dredging of the outer removal area and placement of the capping material was completed relatively quickly at the end of the project, which allowed NW Natural to makeup for several days of delays. The expedited schedule was primarily due to the fact that some portions of the outer containment system could be placed concurrently with final dredging of the inner area, the outer area volume was significantly less than the inner removal area volume, and most of the issues resulting in delays during the early portions of the project had been rectified. Although NMFS issued a Biological Opinion Amendment, which would allow NW Natural to conduct limited work beyond the in-water fish window (July 1 through October 31), all capping was complete by October 30, 2005. Limited site activities, primarily related to demobilization, occurred after the in-water fish window construction period. It is not expected that actions conducted after the fish window closure had any adverse impact on aquatic life or environmental conditions in the river.

One of the limiting factors related to the schedule was the availability of transport barges. The transfer of material by barge to the Port of Morrow takes approximately one day to complete and one day for return. Due to the unanticipated length of time in which it took the barges to be unloaded at the transfer facility, the turnaround time for barges took up to one week. Issues related to unloading delays include the characteristics of the dredged material (i.e. there was some initial trial and error regarding addition of cement to get the correct consistency), best management practices used to limit spills/releases (which limited the speed in which the material could be unloaded), and the availability of trucks to transport the material to the landfill. The schedule implemented by NW Natural had adequate flexibility to deal with the time delays. However, the lack of available barges (three barges were being used throughout the project) may have prolonged the removal action unnecessarily.

Field directions from the EPA also resulted in delaying the schedule. After it was discovered that non-aqueous phase liquid (NAPL) was present on the exposed shoreline cut, the EPA directed that an organoclay mat be installed to control the seeps, prior to placement of the pilot cap. Placement of the organoclay mat is estimated to have delayed the removal action approximately one to two days, due to material procurement and delivery, and use of dredge equipment/personnel to place the mat. In addition, the implementation of the barge water treatment system, which was required by the Biological Opinion after water quality exceedances were identified downstream of the containment area, also impacted the project schedule. Conditions of the Biological Opinion required that the system be implemented prior to re-starting dredging activities, resulting in approximately two days of equipment procurement and installation. A relatively small area (less than 100 cubic yards) of visibly contaminated material outside the dredge prism was also requested by EPA to be removed. This did not significantly delay the removal action implementation.

2.2.2 Dredging

A total of approximately 15,300 cubic yards of tar and tar-contaminated sediment were removed during the GASCO removal action. The dredged material was shipped via barge to the Port of Morrow in Boardman, Oregon, and offloaded into trucks and hauled under manifest to the Chemical Waste Management Northwest Subtitle C landfill in Arlington, Oregon.

Dredging of the tar and tar sediments was performed using a derrick-mounted dredge crane equipped with a clam-shell type dredge bucket or a closed cable arm bucket. The nature of dredge material dictated which dredge buckets were utilized. When practicable, the closed arm bucket was employed as part of utilizing best management practices (BMPs). Based on estimates from Sevenson Environmental Services (the dredging contractor), approximately 1,600 to 2,000 cubic yards of material was removed with the cable arm bucket and approximately 13,300 to 13,700 cubic yards were removed with the clamshell bucket. Because there were a number of changes between the closed cable-arm bucket and clam-shell bucket, and only one chemical water quality sample set was collected per day, no definitive conclusions can be made as to whether the changes impacted dissolved chemical water quality. However, visual observations (which could not be definitely corroborated with field measurements) indicated that there was somewhat less disturbance and/or less turbidity using the closed cable-arm bucket.

Impacts to river water quality appear to have been affected by dredging methods. As such, the most critical component to successfully removing the tar body while minimizing impacts to water quality greatly relied upon BMPs employed by the dredging contractor. In general, the dredge operators employed the standard dredging controls, and, when directed, were diligent at employing additional/modified BMPs. However, there were isolated instances when the dredging production rate resulted in a failure to implement some of the BMPs. Examples of these occurrences are as follows:

- <u>Over-filling of dredge bucket</u>: At the onset of the removal action, several instances of overfilling of the dredge bucket were observed. These instances were generally related to variations in consistency/hardness of the dredge material. The dredge buckets available (clam shell, cable arm) have their respective applications based on the physical characteristics of the tar body or sediment. The cable arm bucket, with the advantage of being a lighter closed bucket, does not, however, effectively cut into harder material. The conventional clamshell bucket, being much heavier and equipped with tines, would on occasion be overly effective at biting into the tar material, resulting in over-filled buckets. As such, the dredge operator was at the limits of the available equipment due to the heterogeneous nature of the tar deposit and sediments. However, overfilling of the dredge buckets were substantially minimized as the project progressed.
- <u>Dragging of bucket on river bottom</u>: On one occasion, during the latter half of the project, the dredge operator was observed to be moving the dredge bucket in a fashion that suggested the operator was dragging the dredge bucket along the river bottom, which was prohibited as part of BMPs. However, discussion with the contractor indicated that the operator was not dragging the bucket, but rather looking for "high spots." With the bucket suspended at a specified depth the contractor moved the bucket back and forth to ensure the desired dredging depth had been

achieved. Although not in contact with the river bottom, the contractor was directed to cease that type of activity.

- <u>Splash dunking of the bucket</u>: On one occasion the dredge operator aggressively splash dunked the dredge bucket in the river to clean off material at the end of the day, prior to placing the bucket on the derrick. This appeared to be an isolated instance, but the operator was directed to cease that practice. Subsequently, the bucket was decontaminated with hose water on the transfer barge, or simply placed on the derrick when there was little or no residual dredge material adhering to the bucket. Additional occurrences were not observed.
- <u>Cycle time</u>: On occasion it was noted that an increased dredging production rate resulted in a failure to implement some of the BMPs. As a result, the contractor was regularly reminded of the required pace by the EPA contractor and would respond accordingly.

Observations and discussion of additional BMPs are further described in Section 3.9.

2.2.3 Final Grade/Capping

Bathymetry surveys were conducted throughout the removal action to monitor the dredging depths, and were also utilized at the end of the project to confirm the final elevations achieved. Additionally, final confirmatory depth and thickness surveys were conducted manually using a lead line. Completion of the removal action involved placing an organoclay mat along the dredging cut-face at the rivers edge, followed by a pilot cap (quarry spall) over the dredge prism. The entire inner removal area was then overlain by a layer of fringe cap material (sand) up to the 10-foot high water line on shore. Thickness of cap placement was verified by bathymetry survey and diver survey.

Upon completing placement of the fringe cap, the containment structures (silt curtains, anchors, bubble curtain, etc.) were removed and treated as solid waste. Onsite trailers and ancillary equipment were removed from the site. In general, no significant issues were observed with the final grade of the site, capping material and procedures and/or demobilization.

2.2.4 Transfer Facility

Demobilization and decontamination of equipment at the offloading facility in Boardman, Oregon, was completed approximately 10 days after work was completed at the GASCO site. Decontamination of barges, machinery and equipment at the offloading facility was done using pressure washers. Washing of equipment (excavator buckets, front-end loaders, etc.) was performed by placing the equipment inside the haul barge such that the waste water was captured. The water was then pumped to a vacuum truck and hauled offsite to the Arlington disposal facility. All of the material containment equipment used at the site (lay down mats, visqueen, hay bails, cover soil, etc.) was removed and hauled offsite. The area was then graded to its’ original condition. No significant issues were observed with operations of the transfer facility.

Soil samples were collected from the transfer facility to evaluate whether spills or releases had occurred during the removal action. Transfer facility post-construction sampling is further discussed in Section 3.11.

3. DATA EVALUATION AND PROJECT REVIEW

During the course of the removal action, a number of issues were identified by the EPA project team that requires additional evaluation beyond that included in the RACR. These issues include design elements (containment system), water quality criteria exceedances, best management practices, and response actions. Because the GASCO early action was one of the first early actions undertaken within the Portland Harbor Superfund Site, the EPA project team indicated that the issues encountered during the project may be helpful in guiding future early actions in the Portland Harbor. Therefore, this section is intended to provide additional evaluation, both quantitatively and qualitatively, of several specific issues identified and provide “lessons learned” that may be useful in future early actions. In addition, the lessons learned evaluation was also designed to help evaluate why the project did not perform as designed with respect to water quality exceedances and to evaluate the offsite and short-term impact of the project to the extent possible with the available data.

It should be noted that the intent of this section is not to reiterate all of the data collected during the project. The RACR provides a detailed presentation of the data and largely includes adequate evaluation of most issues encountered. This report only includes those issues which may have applicability to future actions at GASCO or elsewhere in the Portland Harbor area.

3.1 BACKGROUND WATER QUALITY SAMPLING / WATER QUALITY CRITERIA

In order to evaluate the effectiveness of any containment system to control water quality impacts due to dredging, background conditions at the site need to be fully understood. In July 2005, the EPA prepared a Clean Water Act 401 Water Quality Certification (WQC) (EPA 2005b), which included both chronic and acute water quality criteria. In accordance with the WQC, exceedance of chronic criteria during the project would result in increased monitoring and a review of dredging operations and BMPs. Exceedance of acute criteria would result in immediate project shutdown, implementation of all available BMPs, and consultation with EPA prior to re-initiating dredging operations.

Prior to the start of the project, background sampling for the WQC-required water quality constituents (semi-volatile organic compounds [SVOCs] and cyanide) were collected from three upstream locations. The results of the background sampling is included in Table 15 of the RACR and provided as part of Appendix D, Supporting Documentation in this document. In general, low to moderate levels of SVOCs were detected in the background samples collected. The chronic criteria for benzo(a)pyrene (0.014 micrograms per liter [μg/L]) was exceeded in two samples, RAA-WBGDB (0.0532 μg/L) and RAA-WBGDB (0.0485 μg/L). No acute water quality criteria were exceeded during the initial background sampling. The results indicated that low levels of project-related constituents were present upstream of the project area were at concentrations exceeding those referenced in the WQC. The presence of these compounds likely had some impact on water quality sampling results and the ability to meet project-specific criteria.

Within the first week of dredging, water quality sampling indicated elevated concentrations of contaminants downstream of the project area (see Table 17 in Appendix D). Several samples indicated concentrations of benzo(a)pyrene and benzo(a)anthracene significantly above the acute criteria established in the WQC. Based on these results, all available BMPs outlined in the RAPP were implemented. In addition, as part of the response actions, the EPA directed NW Natural to complete additional background sampling to determine if the impacts were project related. A total of eight additional background sampling locations (all containing three different depths) were sampled on September 16, 2005 and September 29, 2005, during periods of non-dredging to try to gain a better understanding of river conditions. The additional background sampling results are shown on Table 16 of the RACR (and included in Appendix D). The chronic criteria for benzo(a)pyrene, and to a lesser extent for benzo(a)anthracene, were exceeded in most of the additional samples collected. The acute criteria for benzo(a)pyrene and benzo(a)anthracene was also exceeded in 12 of 43 samples collected and 7 of 43 samples collected, respectively.

Because the additional background sampling was conducted long after the dredging operation had been initiated at the site, it is difficult to determine whether the later samples are truly representative of background conditions. At that point in the project, the dredge prism had been significantly disturbed and new material had been exposed. The presence of the containment system, which likely included high concentrations of constituents within the contained water column, also may have contributed to leaching out of contaminants through the silt curtain (see discussion in Section 3.3.1). While the sampling was conducted during periods of non-dredging, dredging had occurred within 48 hours prior to the water quality sampling during both events.

It is important to note that NW Natural collected the additional "background" samples at the request of EPA and included the sample results as part of the presentation of background conditions in the RACR. However, this data should not be assumed by NW Natural or other parties to be truly representative of background conditions. In the event that the GASCO project is referenced for future removal actions, establishment of water quality criteria (trigger levels), and evaluation of potential impacts should be independent of the data collected during this project. Future projects which include a chemical water quality program should include an extensive background evaluation which should be considered when establishing water quality criteria in the WQC or other regulatory document. As observed with the GASCO project, there is potential that ambient conditions may exceed water quality criteria and may impact the ability to meet project-specific criteria.

3.2 WATER QUALITY SAMPLING PROGRAM

A water quality sampling program was established in the WQC to evaluate the effectiveness of the containment system and to measure the potential impacts on the aquatic environment due to the removal action. Water samples were collected concurrently for field and laboratory analysis from three depths at three pre-determined stations, typically one station upstream (300 feet from containment barrier) and two stations downstream (150 feet from the containment barrier). However, after approximately 6 days of limited dredging, a dead fish was observed in the containment area (September 13, 2005). Coupled with the exceedance of water quality criteria, the EPA immediately expanded the water quality sampling program. Figure 5 shows the various locations from which water quality samples (for both field and laboratory parameters) were collected during the removal action. Sampling locations were regularly governed by the direction of river flow. In tidal-influenced or reverse-flow conditions, which was observed periodically throughout the GASCO project, sampling locations were reversed from downriver to upriver locations, and vice-versa for the background locations.

Water quality samples were collected daily, initially after a minimum of one hour of dredging activity and then after approximately 4 hours of dredging. Samples submitted to an offsite laboratory were analyzed for a project-specific list of SVOCs and cyanide. Onsite analysis of water samples included field measurement of turbidity, dissolved oxygen, temperature, conductivity and pH, and visual observations. The additional chemical sampling required by the EPA resulted in a total of 13 locations being sampled on a daily basis during the later stages of the project. The complete results of water quality data collected during the project are presented in the RACR (Anchor 2006b).

The robust chemical water quality sampling program required by EPA during the removal action indicated exceedances of water quality criteria listed in the WQC. While some projects have used chemical water quality monitoring, traditional sampling programs primarily rely on field measurements, including turbidity, temperature, dissolved oxygen and visual indicators, to assess water column impacts from dredging. In fact, NW Natural proposed only using field measurements during the initial draft of the RAPP. The chemical water quality program was added after negotiation with NW Natural during a formal dispute resolution. The exceedances of chemical water quality criteria resulted in a number of criticisms to NW Natural and EPA from the public, environmental groups, and other entities. Based on the data collected, it is clear that the traditional field measurements would not have resulted in the perceived problems with the project. However, the criticism from the public should not discourage EPA from requiring chemical water monitoring programs. In fact, the experience at GASCO should be used to justify additional chemical sampling in order to ensure that actual impacts to water quality are being properly assessed during early actions. The sampling program required by EPA was appropriate and effective in demonstrating the impacts to water quality from the removal action.

3.3 SILT CURTAIN CONTAINMENT SYSTEM / IMPACT ON WATER QUALITY

The in-water containment system was made up of several components including permeable and impermeable silt curtains, a bedload baffle anchored to the river bottom, floating booms and a hanging skirt on the outside of the silt curtains, and a bubble curtain around the entire perimeter of the containment area (Figures 3 and 4). One of the major issues identified during the project by the EPA project team was the relative effectiveness of the containment system to control potential impacts to water quality due to dredging and disturbance of the tar body. While the chemical data collected at the site is relatively limited, the effectiveness of the silt curtain and other components can be evaluated using the spatial distribution of contaminants detected during dredging operations. In general, benzo(a)pyrene and benzo(a)anthracene were used as indicator compounds to evaluate the water quality data. Benzo(a)pyrene and benzo(a)anthracene have the lowest water quality criteria established in the WQC and were generally detected in the majority of samples. An evaluation of the containment system effectiveness is presented in the following sections.

3.3.1 Concentration Gradient across Silt Curtain

As part of the expanded sampling effort, water samples were collected from just inside and outside the silt curtain to evaluate the concentration gradient across the silt curtain. The data is assumed to represent the relative effectiveness of the silt curtain to control the release of contaminants to the water column. The locations of the samples are shown on Figure 5.

A total of fourteen pairs of samples were collected between September 27, 2005 and October 22, 2005. Six of the sample pairs were collected during dredging of the inner removal area to evaluate the effectiveness of the full length silt curtains and eight sample pairs were collected during dredging of the outer removal area to evaluate the partial length silt curtains. The results are discussed in the following sections.

3.3.1.1 Full Length Silt Curtain Effectiveness

It should be noted that the samples collected inside and outside of the full length silt curtain were collected in the downstream location where the permeable silt curtain was located

(Figure 5). As shown on Table 1 and Figure 6, the average concentration of benzo(a)pyrene detected in water samples collected from inside and outside the full-length silt curtain during dredging was 10 µg/L and 1 µg/L, respectively. The percent reduction across the silt curtain ranged from 36.4% to 99%, with an average percent reduction of 80.4% (Table 1).

The limited data indicates that the full-length permeable silt curtain was relatively effective at reducing the concentrations released to the water column during dredging. The average concentration of benzo(a)pyrene observed within the contained area was approximately 40 times the acute criteria established in the WQC. Because the silt curtain perpendicular to the river was constructed of permeable fabric, it was not expected that such a high buildup of contaminants would occur within the containment area. Field and diver observations during dredging indicated that a large amount of silt buildup was observed on this portion of the curtain, which may have reduced the permeability. As such, the silt curtain appears to have been very effective at containing suspended solids, relative to the partial-length silt curtain used in the outer removal area. Visual indications of the water within the containment area indicated very turbid conditions. However, field measurements of turbidity at the downstream compliance point did not indicate significant exceedances of the turbidity criteria at any time during the project.

Although there was a relatively large concentration gradient across the silt curtain which indicates its relative effectiveness, it is important to note that the silt curtain was not effective at reducing the concentrations outside the containment area to below the acute criteria established in the WQC.

3.3.1.2 Partial Length Silt Curtain Effectiveness

As shown on Table 1, the average concentration of benzo(a)pyrene inside and outside of the partial length silt curtain was 0.6 µg/L and 0.2 µg/L, respectively. The percent difference across the silt curtain ranged from an increase of 153% to a reduction of 85%, with an average reduction of 26%.

The variability of the limited data set is likely due to the use of partial silt curtain for the outer containment design. The design called for the silt curtain to hang approximately 2 feet above the river bottom. A bedload baffle, set on the interior side of the silt curtain and offset approximately 10 feet, extended from the river bottom upward into the water column (see Figure 4). The resulting gap between the containment structures likely allowed flow to occur between the contained area and the river channel. It is not expected that the contaminant concentration or dissolved-phase contaminants released from the tar body was significantly different in the outer dredge prism area. Therefore, the significantly lower concentrations observed within the containment area, and similar concentrations on the outside of the containment area, were likely due to the equalization of contaminants due to the flow beneath the silt curtain.

It is important to note that the benzo(a)pyrene concentrations observed outside of the containment area were slightly above the acute criteria. The lower concentrations observed in the water column outside the containment area should not be attributed to the effectiveness of the silt curtain. More likely, the low concentrations observed are due to the dispersion and dilution of contaminants. It appears that more contaminated particles were lost using the partial-length silt curtains than the full-length silt curtains. However, there is not sufficient data to differentiate the mass loss between the partial and full-length silt curtains.

3.3.2 150 Feet Downstream of Containment Area

Assessment of impacts to river water quality were based on contaminant concentrations detected at sampling stations situated along an arc 150-feet downstream of the primary containment area. These sampling stations included RAA-WCD1 through RAA-WCD3 during normal flow conditions and RAA-WCU4 through RAA–WCU6 during reverse flow conditions. Figures 7 and 8 show the concentration of benzo(a)anthracene and benzo(a)pyrene detected at 150 feet downstream of the containment edge at the surface, middle, and bottom depths throughout the project. Figures 7 and 8 also include the acute criteria established in the WQC.

The acute criteria for benzo(a)anthracene (0.49 µg/L) and benzo(a)pyrene (0.24 µg/L) were generally exceeded throughout much of the dredging phase of the project. Typically, the concentrations detected were highest in samples collected from the bottom depths (approximately 1 foot above river bottom) and lowest in samples collected from the top of the water column (approximately 1 foot below surface). The 95% upper confidence limit (UCL) was calculated for specific data sets, including initial stages of the project prior to implementation of BMPs, after implementation of all BMPs, and dredging of the outer containment area.

The 95% UCL for concentrations of benzo(a)pyrene and benzo(a)anthracene were significantly higher than the acute criteria during the initial stages of the project. As required in the WQC and further discussed with the EPA project team, BMPs were necessary to limit the water quality impacts. Some of the BMPs employed at the site included:

- Moving the bucket more quickly from the water surface to the transfer barge to allow less of the water to drain back into the water column;
- Increasing the dredge cycle time within the water column, including slower descent and ascent of the dredge bucket;
- Minimizing overly full buckets;
- Installation of a dewatering treatment system on the barge to treat dredge water prior to discharging it to the contained area; and

Twelve days into the dredge project (September 19, 2005), all available BMPs were operational. Additional water quality sampling was directed by EPA to measure the effectiveness of the BMPs. Based on the data collected, it appears that the additional BMPs had a significant effect on water quality. As shown on Figures 7 and 8, the 95% UCL was significantly lower than previously observed. However, the concentrations of benzo(a)pyrene and benzo(a)anthracene still exceeded the acute criteria established in the WQC.

Once the outer removal area containment system was initiated, significant decrease in benzo(a)pyrene and benzo(a)anthracene concentrations were evident (Figures 7 and 8). Much of the decrease can be attributed to the nature of the outer containment system. However, it is important to reiterate that although the water quality results appear to be better for the outer removal area (and partial silt curtain system), it should not be concluded that it is a better control for the release of contaminants. As previously discussed, the outer containment system utilized a partial silt curtain, coupled with a bedload baffle. A relatively large gap was present between the silt curtain and bedload baffle, which likely allowed flow of water from the containment area to the river channel. This flow allowed the dispersion of the contaminants from the containment area. The contaminant concentrations observed just inside and outside the silt curtain supports this conclusion.

After the dredging was complete, water quality samples were collected during installation of the pilot cap. As shown on Figures 7 and 8, the concentrations of benzo(a)pyrene and benzo(a)anthracene were very near or below the acute criteria during this time period.

3.3.3 600 Feet Downstream of Containment Area

Due to water quality exceedances observed at the 150 foot sampling station, the EPA directed NW Natural to collect water quality data further downstream to evaluate the lateral dispersion of contaminants. A sampling station was established approximately 600 feet from the containment barrier (Figure 5). Data collected from the 600 foot downstream station includes 15 data points (with top, middle, and bottom sampling depths) collected between October 12, 2005 and October 29, 2005. A total of eight samples were collected during dredging of the outer area with the remaining samples collected during installation of the pilot cap. The analytical results are included on Table 2.

The results show relatively low concentrations of benzo(a)pyrene and benzo(a)anthracene in the farthest downstream samples collected. However, the acute criteria for benzo(a)pyrene was routinely exceeded for samples collected at the bottom depth. When compared to the samples collected at 150 feet downstream during the same time period, the results are not significantly different. Thus, it can be concluded that impacts were dispersed downstream to some extent. The lateral extent in which water quality was below acute criteria is unknown.

3.3.4 Turbidity

In the majority of dredging projects, specifically within EPA Region 10, turbidity has been a primary parameter used to measure impacts to water quality. As evidenced by the GASCO project, chemical analysis is costly and generally cannot be completed in real-time. It has been generally thought that turbidity can be correlated with chemical data and can be used as an indicator of water quality impacts. However, because of the highly concentrated chemical makeup of the tar body and the unknown effectiveness of the designed containment system, the EPA required NW Natural to include a relatively robust chemical monitoring program. Field measurements (turbidity, DO, and temperature) were also measured extensively throughout the project.

3.3.4.1 Correlation with Chemistry Data

Figures 8 and 9 show the maximum turbidity measured an any given day (at the same sampling station) overlain with the benzo(a)anthracene and benzo(a)pyrene data collected throughout the project. In general, the daily maximum turbidity observed correlated with the detected benzo(a)pyrene and benzo(a)anthracene concentrations throughout the duration of the project (i.e. spikes in turbidity were typically matched by spikes in chemical concentrations). However, the data is somewhat variable and the correlation is only general in nature. For the data set collected during this project, it is not expected that a specific turbidity measurement can predict a chemical concentration of either benzo(a)anthracene or benzo(a)pyrene.

The correlation is even less pronounced after the outer removal area containment system was initiated. It appears that this is due to the dilution/release of water within the dredge area to the river channel from beneath the partial silt curtain/bedload baffle system. Once the capping phase of the project commenced, there is no apparent correlation of turbidity to chemical concentrations. The detected concentrations of benzo(a)pyrene and benzo(a)anthracene dropped substantially while turbidity increased significantly due to the large amount of sand material being placed into the river.

It was anticipated that turbidity would be one of primary water quality certification triggers for requiring additional BMPs. However, based on the observed background turbidity levels and the associated 95% UCL of 17 NTU, turbidity was, on average, below this limit throughout the project. As such, other than a few small exceedances by less than 5 NTU, turbidity did not become a trigger for the project. Similarly, dissolved oxygen, pH, temperature and conductivity were not exceeded. The EPA requirement for chemical testing ultimately drove the requirement for implementing all available BMPs.

3.3.4.2 Effect of Bubble Curtain on Turbidity

In order to prevent fish passage into the removal action area, the perimeter of the site was lined with a bubble curtain. The mechanism involved forcing compressed air into pipes, which was laid on the mudline surface, in which holes were drilled. The compressed air would rise to the surface of the river through the holes in the pipe, thus creating a "curtain" of bubbles around the site. The RACR indicates that the use of the bubble curtain impacted the water quality in the area, primarily by increasing turbidity. A review of the turbidity data during operation of the bubble curtain and shut down of the bubble curtain was reviewed. The visual indications of increased turbidity near the bubble curtain (which was noted by both Anchor and Parametrix field personnel throughout the project) do not appear to be substantiated by the actual field measurements.

The bubble curtain was continuously used from September 5, 2005 to October 12, 2005. The maximum turbidity reading during the two week period leading up to October 12, 2005 (September 27 through October 12) was 12 NTU, with an average turbidity reading of approximately 6 NTU. The bubble curtain was turned off on October 12, 2005 and approximately six days of dredging were completed without the bubble curtain in place. The maximum turbidity reading throughout this period was 12 NTU, with an average turbidity reading of approximately 5 NTU. A review of the data indicates that turbidity was not significantly less after the bubble curtain was shut down. The most significant impact on turbidity appears to have resulted from the change from the inner dredge area to the outer dredge area.

3.3.5 Physical Stresses on Containment System

There was a concern as to whether the silt curtain could physically withstand river forces. Per the silt curtain manufacturer, a river velocity of 1 foot-per-second (fps) was established as the maximum allowable river velocity that the silt curtain could withstand and below which dredging could proceed. Per the WQC, a river velocity greater than 1 fps would trigger work stoppage. River velocity did not exceed 1 fps during the removal action. As such, it can be concluded that the silt curtain was strong and anchored well enough to withstand the anticipated river forces.

However, there were failings of the silt curtain that resulted from forces other than those generated by the river. Failings of the silt curtain included tears, isolated billowing of the contractor access gate, temporary submergence of the upper silt curtain flotation device, and an instance of a river-bottom anchor being pulled out. These failings were attributable to errors in design and/or human error and are discussed below.

Tears in the silt curtain and failing of one of the anchors occurred during repositioning/maneuvering of equipment close to the curtain. The tears resulted from the curtain catching on the corner of the derrick during repositioning. The anchor came loose as a result of tug wash during maneuvering of a 700-foot tanker vessel immediately adjacent to the curtain. Both situations were immediately corrected by the contractor.

Billowing of the silt curtain and the resulting temporary passage through the containment structure was observed at the contractor access gate (see photograph in Appendix C). This was observed during the latter half of the removal action while dredging in the outer removal area. In this instance, reverse river flow conditions and subsequent forces resulted in billowing of the top portion of the gate mechanism (upper 14-foot portion), effectively creating a gap below the upper portion and the silt curtain anchored on the river bottom. Billowing of the access gate was not observed during normal river flow conditions. As a result, since the billowing of the curtain occurred only during reverse flow conditions, river water was capable of only entering the containment area, as opposed to exiting through the contractors' gate. Nonetheless, it was a failure in design which could increase the release of contaminants to the river.

In order to rectify the billowing of the access gate, the mechanism was modified with the addition of weights and a strapping mechanism that was effective at keeping the top portion of the silt curtain hanging to the desired depth. In addition, usage of the access gate was reduced, utilized only when barges of capping material were maneuvered into the inner containment area. Future removal actions with silt curtains should consider these design issues.

Submergence of the upper silt curtain flotation boom was observed during the early stage of the dredging process upon removal of material from the river-ward edge of the inner removal area. With the creation of a low lying area immediately inside the silt curtain, bottom material immediately outside of the inner silt curtain sloughed towards the low lying area, pulling the bottom of the silt curtain downward, drawing the silt curtain taught and resulting in submergence of the flotation boom. The boom typically was submerged less than a foot below the water surface. This was promptly corrected.

Positioning of the transfer barge immediately adjacent to the silt curtain may have also contributed to submergence of the flotation boom by coming in contact with the tie-back cables extending river-ward from the silt curtain. It appeared that as the transfer barge was loaded and its draft increased, the bottom of the barge would contact the tie back cables, drawing the curtain taught and further exacerbating the issue of submergence. Submergence of the silt curtain was rectified by placing a similar stretch of full-length curtain on the shore-ward side and anchoring it to the bottom, effectively "doubling up" the curtain. Submergence of the secondary stretch of silt curtain did not occur and visual monitoring of the additional curtain did not indicate passage of sheen or water flow in this area of the containment structure.

3.4 ALTERNATIVE TECHNOLOGIES

The EPA project team indicated that it may be appropriate to provide a brief evaluation of alternative technologies.

3.4.1 Comparison to Sheet Pile Containment

During the planning stages of the project, the EPA project team initially indicated that a sheet pile containment system may be best suited to control the relatively mobile contaminants expected to emanate from the tar body during dredging. NW Natural indicated that the silt curtain system would meet the project objectives. As a result of the dispute, the silt curtain and sheet pile containment systems were evaluated in the EE/CA (Anchor 2005a). Based on the evaluation, the silt curtain system was selected, primarily due to the significantly higher costs and logistical issues with sheet pile wall fabrication and installation/removal. The silt curtain design included in the EE/CA was a more robust system than originally presented to EPA in the Draft RAPP.

As discussed in previous sections, a number of water quality criteria exceedances were observed throughout the GASCO project, even with the installation of a robust silt curtain containment system. It is not known whether the sheet pile walls would have resulted in significantly different water quality impacts. In order to properly evaluate the two containment systems, a comparable sheet pile wall project must be identified. That is, the contaminants should be similar (constituents, mobility, concentration, etc.) and adequate water quality monitoring data should be available. However, based on a limited review of dredging projects conducted throughout the U.S., Parametrix could not identify any comparable projects, primarily due to the lack of chemical water quality monitoring. Therefore, a direct quantitative comparison can not be made.

Concerns associated with the implementation of a sheet pile containment system include the logistics of fabricating and transporting the sheet pile walls, time constraints of manufacturing and placement (which would have delayed the GASCO project up to a year), and the potential for contaminant releases during placement and removal of the sheet pile walls. Many of these concerns were evaluated in the EE/CA (Anchor 2005a), which resulted in the selection of the silt curtain alternative.

It is unknown whether that the use of sheet pile walls would have resulted in less short-term impacts to the river. While likely controlling water quality exceedances during the dredging due to superior containment, there is potential that installation and removal of the sheet pile walls would have resulted in substantial releases. As observed throughout the GASCO project, several areas of the tar body exhibited highly mobile features and released substantial sheen at even the slightest disturbance. The installation of sheet pile wall would likely exacerbate contaminant releases. In addition, during removal, there is potential that releases could occur due to smearing of the tar body onto the sheet pile as it is pulled out of the river. Some of these concerns may be rectified by the installation of secondary containment systems during installation and removal. Further analysis would be required to fully understand the potential for water quality issues and sediment resuspension during sheet pile installation and removal. In addition, the concentration buildup of contaminants within the sheet pile containment area (which was observed using the silt curtains) must be considered after the project is complete. Treatment of the water may be possible, but would likely significantly increase overall project costs.

The removal action would also have been delayed for at least one year due to the logistical considerations of equipment procurement, sheet pile wall fabrication, and the available in-water construction window. In the absence of any actions for one year, it is expected that the low concentration releases from the tar body would continue.

Although a direct comparison of the containment systems can not be made, sheet pile containment may be a viable option for future projects. The financial and logistical issues with sheet pile walls may be lessened for longer term dredging projects. Considerations for release of contaminants during installation and removal may be rectified with the addition of other containment mechanisms during these periods. The type of contaminants and the relative effectiveness of the silt curtain containment at GASCO should be considered when evaluating other containment alternatives.

3.4.2 Hydraulic Dredging

Dredging during the GASCO project utilized a combination of clamshell and cable arm bucket technologies. Both of these technologies resulted in significant disturbance of the dredged sediment and contributed to releases of contaminants to the water column. When properly applied, the cable arm bucket, being a closed system, was observed to be much better at controlling releases due to significantly less interaction between the material in the bucket and the water column as it is raised to the surface. However, when the cable arm bucket was not fully closed, some sediment (although less than observed with the clamshell) was released during movement to the surface. Due the consistency of the GASCO tar body, the cable arm bucket could only be used for approximately 10% of the dredged volume. It is estimated that approximately 1,600 cubic yards to 2,000 cubic yards of the total 15,300 cubic yards was dredged with the cable arm bucket.

Hydraulic dredging was considered during the early stages of the RAPP and EE/CA analysis. However, hydraulic dredging was quickly dismissed by NW Natural, which cited concerns with the physical condition of the tar body (i.e. areas of hard brittle tar, etc.) and other logistical concerns, including dewatering the sediment and management of decanted water. However, hydraulic dredging should be considered with any future dredging projects at GASCO or other Portland Harbor sites. The significant advantages of hydraulic dredging to control potential water quality impacts may outweigh disadvantages due to financial or logistical concerns. In addition, the use of hydraulic dredging may significantly reduce the necessity of containment structures. Future dredging should re-evaluate this alternative, including the use of pilot tests or other means to more fully evaluate the alternative.

3.5 OBSERVANCE OF NAPL/SHEENS

Based on the information collected during the tar body characterization, NW Natural indicated in the RAPP that sheens from the dredging process would be limited. However, sheens emanating from the tar material were present throughout the removal process. Any contact with the tar material by the clamshell resulted in a surface sheen. In addition, boat wash directed towards the dredge material or bottom sediments also resulted in surface sheens on a number of days. Although the containment structure incorporated sorbent booms deployed around the perimeter of the inner containment area, it was not anticipated that sheens would be produced to such a degree.

Promptly upon observing the high level of sheening within the first week of dredging, additional sorbent booms were deployed within the inner containment area. Additionally, EPA requested sorbent booms be changed out as soon as they appeared saturated or ineffective at absorbing the sheens. Spent sorbent booms were included with the dredge material hauled offsite and treated as hazardous waste. No sheens were observed migrating outside the sorbent booms and the inner containment area throughout the duration of the removal action. Prior to switching to the outer removal area, sheens remaining in the inner area were skimmed using sorbent boom and mopped up.

Non-aqueous phase liquids (NAPL) were not observed during the characterization of the tar body. However, NAPL was observed along the cut face of the shoreline area. Based on these observations, the EPA directed NW Natural to install an organoclay mat over the area, prior to backfilling with cap material. Details of the organoclay mat are included in the RACR (Anchor 2006b).

It is not known if the NAPL observed along the shoreline continues into the dredge prism. However, based on the substantial amounting of sheening, as well as observations of the tar material removed, there is potential that NAPL is present beneath the river. A relatively large area of NAPL has been documented in the upland portion of the GASCO site, but has not been directly linked to in-water areas, primarily due to lack of sufficient data. The lack of observance of NAPL during the tar body characterization may be associated with the sampling method or the relatively limited cores completed. Several of the samples had little or no recovery in the top portions of the cores. The presence of NAPL, and the potential connection with the upland area, should be further investigated.

3.6 ELUTRIATE SAMPLES / WATER QUALITY MODELING

As part of the characterization of the dredge prism, NW Natural collected four samples (two stations at two depths) of tar material for elutriate analysis using the U.S. Army Corps of Engineers Dredging Elutriate Test (DRET). The elutriate water samples were analyzed for SVOCs, VOCs, petroleum hydrocarbons, and metals. The DRET method is intended as a bench scale simulation of conditions that might be present in the water column close to the dredge. The results of the DRET analysis is included on Table 3 in Appendix D.

The DRET analysis indicated that acute criteria were exceeded for both benzo(a)pyrene and benzo(a)anthracene in all samples collected. The concentrations of benzo(a)pyrene ranged from 0.55 μg/L to 24 μg/L. The concentration of benzo(a)anthracene ranged from 0.76 μg/L to 19 μg/L. The highest concentrations were observed from samples collected from the tar body at 9 to 11 feet below mud line. Although the concentrations were significantly elevated, the DRET analysis is expected to simulate concentrations within a few feet of the dredge and not be representative of concentrations expected downstream. The placement of the containment structure for both the inner and outer removal areas should reduce the concentrations even further for samples collected at the compliance point (150 feet away from the dredge).

Based on the sample results, the EPA requested that NW Natural provide an evaluation of expected contaminant concentrations downstream of the dredge area. The results of the DRET analysis were used in the Kuo-Hayes (1991) model to simulate the expected concentrations in downstream locations. Details of the model runs are presented in the RAPP and in Appendix F of the EE/CA. It is important to note that NW Natural modeled the results assuming that no environmental controls would be in place (i.e. no containment system).

The simulation results (included on Table E-3 in Appendix D) indicated that the 50th percentile for all distances (50 feet, 100 feet, 200 feet, 300 feet, and 400 feet) for all chemical constituents would be below their respective acute criteria. When the 95th percentile were reviewed, only benzo(a)pyrene indicated some exceedances (up to 3.52 times the acute criteria at 50 feet from the dredge). Because of the assumptions included in the model (i.e. no containment system), the model was thought to be an overly conservative estimate of downstream impacts.

Based on actual site data, the 95% UCL of benzo(a)pyrene concentrations 150 feet from the dredge during the 1st week of the project was approximately 4 μg/L, more than 16 times the acute criteria. During the next month, the 95% UCL for benzo(a)pyrene was approximately 2 μg/L, more than 8 times the acute criteria. When the lack of environmental controls assumed in the model are taken into account, it is apparent that the Kuo-Hayes model did a poor job of predicting concentrations of contaminants away from the dredge. While it is beyond the scope of this report, it may be interesting to use the actual concentrations detected at the site to evaluate the sensitivity of different input parameters in the Kuo-Hayes model.

It is interesting to note that the DRET analysis did a better job of predicting the downstream concentrations. The DRET analysis is intended to mimic the concentrations very close to the dredge (within a few feet). However, the DRET concentrations are within the same range as actually observed 150 feet downstream. Part of this may be the fact that the silt curtain, specifically in the case of the inner area full-length silt curtain, appears to have acted as a retention area in which high concentrations of contaminants built up over a period of time due to constant dredging and disturbance of the tar body. This high build up may have exacerbated the downstream impacts due to constant and consistent leaching of contaminants from the silt curtains. When the partial length curtains were used, the downstream concentrations were significantly lower, likely due to contaminant dispersion and dilution. It is possible, that in the absence of any containment, dispersion and dilution would allow downstream concentrations to be more consistent with the Kuo-Hayes model.

The lack of model and field correlation may be due to the presence of NAPL, insufficient number or representativeness of DRET samples collected, and/or deficiency in the Kuo-Hayes model to incorporate high concentrations of contaminants. Calibrating the model with actual field data may be appropriate for future actions. In addition, alternative models should be explored and evaluated for applicability. It should be noted that pilot tests are likely to be more reliable than modeled data.

3.7 IMPACTS TO FISH

On three occasions during the dredging process, dead and/or distressed fish were observed within the primary containment area. As required by the WQC, in each instance dredging was ceased immediately and the appropriate regulatory agencies notified. Dredging was reactivated upon approval obtained from NMFS and the EPA (see the RACR for details). No distressed fish or dead fish were observed outside the containment area during the removal action.

Fish seining was performed within the inner containment area prior to initiating the removal action. Approximately 175 fish were removed from the inner containment area. There is potential that the dead fish observed during the removal action could have escaped capture during the seining process, becoming trapped inside the silt curtain, as opposed to entering the dredge area subsequent to placement of the containment structures. This appears to have been verified by a diver survey of the inner containment structure immediately following the first observed fish kill, which did not indicate any curtain tears. However, other means by which fish may have entered the containment area include jumping over the silt curtain or passing through openings such as the contractor gate, unseen tears, or billowing of the curtain.

The first instance of fish kill occurred in the morning on the fifth day of dredging September 13, 2005. The dredge operator spotted a dead adult Coho salmon on the shore within the containment area. The fish was still fresh, and based on observations by EPA personnel, it was concluded that the fish had died within the last 24 hours. No other dead and/or distressed fish were observed that day. EPA directed the contractor to use a fish finder in an attempt at locating and possibly retrieving any additional fish. No additional fish were found within the containment area using the fish finder.

The second instance occurred the following day, September 14, 2005, when a total of 3 distressed juvenile fish were retrieved from within the containment area. Fish retrieved included a 4.5-inch bluegill, a 6-inch sunfish and a 7-inch crappie. Attempts at reviving the fish were unsuccessful and the fish were placed on ice for storage.

The third instance occurred on September 29, 2005, when a total of 8 distressed and/or dead juvenile fish were retrieved from the within the containment area. All fish were less than 2 to 3 inches in length and appeared to be juvenile sunfish, with one crappie.

Per the Biological Opinion issued by NMFS, it was anticipated that up to 50 juvenile and 5 adult threatened or endangered (TE) fish would be killed by the dredging process. One adult

TE fish (the Coho) was retrieved from within the containment area. The remaining were adult or juvenile non-TE fish. No dead and/or distressed fish were observed in the outer containment area or the river adjacent to the removal action.

The observed impacts to fish are consistent with the Biological Opinion. A total of 175 fish had been removed from the site through seining prior to the removal action. Considering that 12 dead fish (some very small) were discovered during the project, the ratio of fish removed to those potentially missed suggests that the seining was a very effective means of removing fish within the containment area, specifically considering that depths of greater than 20 feet were located in the removal areas.

Based on visual observations, the combination of the bubble curtain and silt curtains appeared to be effective at preventing fish from entering the containment area. Parametrix field personnel notes indicate that fish were regularly observed jumping out of the river in all areas of the river, but none were seen within the containment area throughout the removal action. Based on the duration of the project and the low number of fish discovered in the removal action area, the bubble curtain and silt curtains appears to have been effective at discouraging fish from entering the contained area. The actual contribution of the bubble curtain, as opposed to the silt curtain, is unknown.

3.8 ANALYTICAL DATA TURN-AROUND TIME

As directed by the EPA, the RAPP included a requirement for laboratory turnaround time (TAT) of 72-hours for all water quality chemical analysis. This requirement was implemented in order to assist in evaluating whether the containment system was operating as intended. Table 3 shows the days in which the EPA received the results of the water quality sampling. The average time in which analytical results were received by EPA was approximately 10 days. As shown, the 72-hour TAT was routinely not met throughout the project and, in fact, the reporting time to EPA increased in the later stages of the project.

There has been a lot of focus by the EPA project team and others regarding the failure of analytical data to be received in the required timeframe. While the requirements were generally not met by NW Natural, the actual impact on the project should be considered. The failures to meet the 72-hour TAT should also be evaluated to determine what actions should be taken in future projects.

A review of the laboratory data sheets, discussions with the project laboratory and representatives of the EPA Manchester Environmental Laboratory, and discussions with Anchor field personnel, indicated that the failure to meet the 72-hour TAT was due to a combination of factors, including:

- Increase in the number of water quality samples from 3 stations to up to 13 stations;
- Occasional delays in delivering the samples to the laboratory, some of which were exacerbated by collection of samples on Friday or Saturday, which could not be delivered until Monday;
- Very low detection limits required, specifically for SVOCs. The low detection limits require a relatively long extraction process to achieve appropriate QA/QC;
- High initial concentrations of SVOCs, which required one or more dilutions by the laboratory to achieve the proper QA/QC;

- Failure by the laboratory to prioritize the samples. On numerous occasions, the laboratory did not analyze the samples for several days and up to one week after receipt of the samples;
- Failure by NW Natural to request that the laboratory reserve or dedicate laboratory equipment or personnel to the project; and
- An on-site laboratory was not utilized for the project, the availability of which may have resulted in shorter TAT.

Because of the failures to receive laboratory results in a timely manner, the EPA project team had difficulty in assessing the effectiveness of the containment system, specifically within the first weeks of the project. When the laboratory results were received and indicated water quality criteria exceedances, EPA responded by requiring all available BMPs to be implemented (which was completed by September 19, 2005, approximately two weeks into the dredging project). After the BMPs were implemented, timely laboratory results would have been helpful in further evaluating the effectiveness of the BMPs on water quality.

As part of the project review, the following items were identified that may help in reducing laboratory TAT and reporting results to EPA in future projects:

- Treat the laboratory as part of the project team, including discussions on the volume of samples to be expected, as well as a contingency plan if the volume of samples increase throughout the project;
- Require the establishment of alternative laboratories, which can be utilized if TAT can not be met by the contract laboratory or to help assist with a larger volume of samples;
- Set up field screening procedures to identify samples which may contain high concentrations of contaminants and notify the laboratory which samples may be required to be diluted;
- Require same-day (12-hour) delivery of samples to the laboratory. This can be established in the Water Quality Certification;
- Require the laboratory to provide dedicated equipment and personnel to the specific project;
- Discuss laboratory procedures in detail with the laboratory chemists (not office/project manager) to gain an understanding of realistic TAT and potential issues which could delay results;
- Require the laboratory to prioritize the samples (which may increase laboratory costs);
- If possible, require preliminary reporting from the laboratory in order to make general field decisions;
- Require the Water Quality Certification to include immediate reporting of results to the EPA project team;
- Explore the potential for utilizing an on-site laboratory. For extended projects, the financial costs of on-site laboratories may be comparable to off-site laboratories.

3.9 BMPS

This section discusses best management practices (BMPs) utilized during the removal action.

3.9.1 Dredge BMPs

In response to the fish kills and exceedances in acute water quality criteria, dredging activities were modified to incorporate all the BMPs specified in the RAPP (Anchor 2005b) and in the Biological Opinion (NMFS 2005), including some in-field modifications to material handling.

The RAPP specified BMPs to be employed from the onset of the project and included:

- No multiple dredge bucket "bites" (standard control);
- No bottom stockpiling (standard control);
- No dragging of the dredge bucket (project specific control);
- No lateral movement of the dredge bucket under water (project specific control);
- Pausing before opening silt curtain access gate (project specific control);
- Spill aprons (project specific control);
- Reduce or stop dredging during peak currents (project specific control); and
- No dredging during night time hours (project specific control).

Subsequent to the observed water quality criteria exceedances and fish kills, BMPs were modified to include:

- Increased dredge bucket cycle time;
- Maximize lateral movement of a full bucket under water in order to minimize the fall of water draining from the bucket into the river;
- Increase the rate of movement of dredge bucket from water to transfer barge to control amount of spillage to the river;
- Reduce over-filling of the dredge bucket; and
- Installation of a barge water treatment system to treat water from being disposed of into the contained area.

The implementation of the additional BMPs and incorporating the barge water treatment system resulted in a substantial reduction in the detected concentrations of contaminants. As shown on Figures 7 and 8, the 95% UCL of detected concentrations of benzo(a)pyrene and benzo(a)anthracene were reduced by more than 50%. However, the concentrations of benzo(a)pyrene and benzo(a)anthracene generally remained above the acute criteria established in the WQC. It wasn't until dredging was initiated in the outer removal area that detected concentrations of benzo(a)pyrene and benzo(a)anthracene were below the acute criteria.

The additional BMPs utilized at the GASCO site should be considered during future removal action projects. For projects of similar contamination characteristics, additional BMPs may be necessary to achieve the low acute criteria expectations.

3.9.2 Barge De-water Treatment System

In response to exceedances in water quality criteria outside the containment area and the occurrence of dead fish discovered within the inner containment area, the EPA directed NW Natural to install a treatment system for treating the water collected on the barge prior to discharge into the river. The treatment system consisted of a preliminary solids filtering mechanism (screened buckets), followed by an oil/water separator, a secondary solids filter (bag filters), and an activated carbon vessel. The treatment system was on-line by September 19, 2005 and was operational until October 19, 2005, the last day of dredging. The system initially consisted of one carbon vessel, but was later modified to incorporate two carbon vessels in series. The second polishing carbon unit was on-line by October 4, 2005.

In order to monitor the effectiveness of the treatment system, the EPA requested influent and effluent samples be collected from the system on each day the system was used. The influent and effluent samples were analyzed for the same list of analytes as river water quality samples (i.e. SVOCs and cyanide). The full set of results of the influent and effluent samples are included in the RACR. For this analysis, Table 4 shows the benzo(a)anthracene and benzo(a)pyrene results.

As shown in Table 4, the treatment system was effective at reducing the concentrations of benzo(a)anthracene and benzo(a)pyrene. With the exception of 3 days, the treatment system achieved an average percent reduction of 76.7% for benzo(a)anthracene and 69.7% for benzo(a)pyrene. However, the concentrations of these compounds in the effluent remained in excess of their respective acute and chronic water quality criteria. Nonetheless, the treatment system had a positive impact on the nature of the barge water being discharged to the river and helped reduce the concentrations of chemicals being introduced to the water column. The reason for the higher concentrations in the effluent for those 3 days is unknown. However, it may be related to silting of the carbon units and the infrequency in which carbon units were changed out. Due to the delay in water sample results, NW Natural could not anticipate the need for carbon changeout. A monitoring program and evaluation of treatment efficiency should be implemented for all treatment systems incorporated in the removal action. In addition, a regular operation and maintenance plan should be developed and implemented.

3.10 SEDIMENT TRAP AND SEDIMENT STAKE MONITORING

The EPA required the use of sediment traps to be deployed at the site to measure potential dispersion of suspended sediment downstream. Three sediment traps were deployed at the site, one to measure upstream (background) conditions and two downstream at approximately 150 feet and 750 feet from of the outer containment area. In addition, the EPA required the placement of sediment stakes within the outer containment area to further evaluate the potential for deposition of contaminants in the containment area.

Baseline sampling for the sediment traps was completed for approximately 35 days prior to the removal action to provide a comparison of data. The sediment traps were re-deployed prior to the removal action for a period of 82 days. Tables 28 and 29 of the RACR (included as supporting information in Appendix D) include the sediment trap data.

In general, the mass of accumulated sediment was highly variable. In two of the three stations, the mass of sediment collected in the traps was higher in the baseline sampling, even though the duration was approximately half of the post-construction samples. This is likely due to the varying river conditions regarding flow and depositional areas. The placement of the silt curtain containment system, as well as supporting barges and equipment, likely impacted the natural flow regime in the area and may have impacted deposition of suspended sediment.

Because of the low number of sediment traps used and the potential impact of the removal action equipment on the flow regime, a comparison to the baseline conditions is difficult. However, as shown on Table 29, there is an approximately one order of magnitude increase in the detected concentrations of SVOCs in the sediment collected in the post-construction samples. This increase is likely directly attributable to the removal action.

Sediment stakes were not able to be retrieved after the removal action was complete. NW Natural indicated that the sediment stakes were likely removed by derrick barge spuds during times when the derrick needed to provide access to monitoring personnel. Because no evaluation of the sediment stake accumulation was possible, EPA directed NW Natural to extend the fringe cover to the upstream extent of the outer removal area.

As directed by EPA, NW Natural attempted to evaluate the potential mass of tPAHs deposited downstream using the sediment trap data. The evaluation included in the RACR includes hydrological considerations, a comparison of SVOC concentrations in baseline and post-construction samples, and an estimate of deposition mass.

Due to the low number of sediment traps utilized (three) and the data variability, the estimate for the loss of mass downstream is difficult to quantify. The method employed in the RACR appears to be adequate for providing general estimates of the deposition of contaminants downstream. However, the analysis used a variety of assumptions to arrive at the estimates. It is clear that additional sediment trap information is critical for proper assessment of mass loss during a dredging removal action.

Because the GASCO project was one of the first early actions, the use of sediment trap information was limited (i.e. negotiations between NW Natural and EPA resulted in a limited data set). However, sediment trap deployment appears to be a viable and important method in which to evaluate downstream impacts. The costs for deployment of sediment traps and sample analysis are generally not large, considering the total costs of most removal actions. Future dredging projects should consider the use of sediment traps for evaluating the potential loss of contaminants downstream. However, because of the highly variable nature of the river system and the potential impacts of in-water work to affect natural scour and depositional areas, a relatively large system of sediment traps needs to be deployed to be an effective measurement tool. In addition, baseline conditions should be established over a relatively long period of time to account for seasonal fluctuations, as well as the impact of tidal fluctuations (reverse flow conditions were observed a number of times at GASCO during the removal action).

3.11 SEDIMENT OFFLOADING AREA

As part of the transportation and disposal plan (TDP) in the RAPP, samples were collected at the offloading facility in Boardman, Oregon to evaluate tracking of materials offsite. Soil samples were collected in two locations, one at the exit of the load out pad, and one along the shoulder of the public road to the disposal facility (see Figure 15 of the RACR). One set of samples were collected prior to any operations at the site and one set was collected after the facility had been demobilized.

The analytical results are included in Table 9 of the RACR (also in Appendix D). The pre- and post-construction samples near the road did not indicate a significant difference in concentrations of SVOCs. However, the SVOC concentrations in the post-construction samples collected near the load out pad were one to two orders of magnitude higher than the pre-construction samples.

The evaluation in the RACR indicated that the contamination detected in the post-construction samples were unrelated to the project activities. The evaluation included a comparison of the relative percentage of constituents in the transfer facility sample to a sample collected from the visually contaminated material from the dredge prism. According to the analysis presented, the “fingerprint” does not match and, therefore, NW Natural indicated that the post-construction sample collected from the load out pad is not from the tar material.

While the evaluation presented may have some merit, it does not confirm that the contamination detected at the offloading facility was from another source. The sample from the visually contaminated material in the dredge prism was relatively undisturbed prior to the laboratory analysis (i.e. collected using a core through the tar material). Conversely, the tar material transported to the offloading facility underwent relatively vigorous disturbance from dredging and placement on the barge, mixing with cement for stabilization, several days to a week or more of transport time to the offloading facility, and further handling at the offloading facility. These processes have the ability to change the composition of the material due to volatilization and degradation. There is a potential for contaminant composition of samples obtained from the offloading facility to differ from those collected in the in-water area.

While the contamination detected at the offloading facility could be related to the offloading activities, it is not expected that the contamination is extensive. During inspections of the facility and observation of loading operations, very few spills or releases were noted. Those that were observed, including splashing of the material in the hopper during the first days of operation, Parametrix noted that the contractor was very diligent in collecting the material from the ground surface.

It is expected that over the course of two months of operations at the offloading facility and the high volume of trucks passing through the facility, the contaminants detected in the soil sample at the offloading facility could have been the result of spills or releases from offloading operations. However, based on the lack of observations of direct spills, the diligent cleanup efforts of the contractor, and the time in which has passed since the occurrence (11 months) and continued use of the facility since that time, further evaluation or cleanup of the offloading facility is not warranted.

Future removal actions should consider the importance of collecting baseline and post-construction samples from the offloading facility and/or haul routes to assess potential impacts due to project-specific activities. In addition, all observed or suspected spills or releases should be investigated as soon as possible and appropriate remedial actions implemented.

Baseline and post-construction sampling efforts should include the collection of statistically representative sampling locations and quantity, including composite samples and archived sub-samples to identify potential contaminant areas.

4. CONCLUSIONS AND RECOMMENDATIONS

Parametrix provided construction oversight of the GASCO early removal action. Based on observations made during oversight of the removal action and a review of site data, project documents, and other information, Parametrix provides the following conclusions and recommendations:

1. Approximately 15,300 cubic yards of tar and tar-contaminated sediment was removed during the early removal action and disposed at a Subtitle C landfill. A pilot cap was placed over the dredged area to limit future releases of contaminants and to evaluate the applicability of sediment capping technology in future removal/remedial actions at the GASCO site. The early removal action appears to have provided substantial benefit to human health and the environment by removing pure tar material and the highest concentrations of total polynuclear aromatic hydrocarbons (tPAHs) at the site. The long-term benefits, which include limiting the potential for direct exposure to contaminated material by aquatic organisms, reducing continual releases of dissolved contaminants from the tar body to the overlying water column, and limiting the potential for scour and deposition of contaminated sediment downstream, appear to outweigh the short-term impacts of the removal action. Short-term impacts include periodic exceedances of water quality criteria outside of the containment area, a limited amount of dead fish within the containment area, and the potential to have released a limited amount of contaminant mass away from the dredged area.

2. The GASCO early action provided an opportunity to the EPA project team to evaluate a number of issues raised during the project to help facilitate other remedial actions at the GASCO site or removal actions in the greater Portland Harbor Superfund Site. Since the GASCO removal action was one of the first early actions completed in the Portland Harbor, the EPA project team can use the experience gained at GASCO to provide a greater understanding of expected project concerns for dredging projects. The lessons learned from GASCO removal action should be considered in future removal actions in the Portland Harbor.

3. EPA required a relatively robust chemical monitoring program and implementation of chemical water quality criteria in the Water Quality Certification. Traditional sampling programs generally consist of field measurements, including turbidity, temperature, dissolved oxygen, and visual indicators, to assess water column impacts from dredging. The exceedances of water quality criteria during the GASCO project resulted in a number of criticisms to NW Natural and EPA from the public, environmental groups, and other entities. Based on the data collected, it is clear that the traditional field measurements would not have resulted in the perceived problems with the project. However, the criticism from the public should not discourage EPA from requiring chemical water monitoring programs. In fact, the experience at GASCO should be used to justify additional chemical sampling in order to ensure that actual impacts to water quality are being properly assessed during early actions. The sampling program required by EPA was appropriate and effective in demonstrating the impacts to water quality from the removal action.

4. Future projects which include a chemical water quality program should include an extensive background evaluation for water quality and should be considered when establishing water quality criteria in a Water Quality Certification or other regulatory document. As observed with the GASCO project, there is potential that ambient conditions may exceed water quality criteria and may impact the ability to meet

project-specific criteria. Additional background sampling would have been beneficial to evaluate the variability of ambient conditions, specifically representing various weather conditions, wave action, river flow, and upstream impacts/activities.

5. The full-length silt curtain utilized during dredging activities within the inner removal area appears to have been somewhat effective at reducing concentrations of contaminants from entering the river channel. However, the full-length silt curtain was not effective at reducing the concentrations outside the containment area to below the acute criteria established in the Water Quality Certification. For removal actions of similar contaminants and scope, additional containment technologies may be required to meet acute water quality criteria standards. Based primarily on visual observations, the full-length silt curtain appears to have contained suspended particles better than the partial length silt curtain, although no data exists to support this conclusion.

6. The partial length silt curtain utilized during dredging within the outer removal area also had some impact on water quality. Significantly lower concentrations of contaminants were observed during the outer removal operations. However, based on the data reviewed and visual indications, it appears that a significant portion of the lower concentrations detected may be attributed to the apparent flow between the partial length silt curtain and the offset bedload baffle. This gap in containment likely provided a preferential pathway for flow to occur between the contained area and the river. The lower concentrations observed downstream is likely due to dispersion and dilution of contaminants. Though water quality samples were better with the partial-length silt curtain, it appears that more contaminated particles were lost using the partial-length silt curtain than the full-length silt curtains. However, there is not sufficient data to differentiate the mass loss between the two containment systems.

7. The implementation of additional best management practices, including operational changes for dredging and material handling and installation of a barge water treatment system, resulted in an approximately 50% reduction of detected concentrations of contaminants outside the containment area.

8. Chemical water quality criteria exceedances were the primary factor in which EPA directed additional best management practices during the removal action. Other than a few minor exceedances, turbidity was not a driving factor for triggering response actions at the site. Similarly, dissolved oxygen, pH, temperature and conductivity criteria were not exceeded.

9. Although visual observations indicated that the bubble curtain may have contributed to elevated turbidity measurements, a review of the field measurement data does not support this conclusion. This may be due to the periodic nature of field sampling or the heterogeneity of the river bottom near the bubble curtain. The data indicates that turbidity was not significantly less after the bubble curtain was shut down. The most significant impact on turbidity appears to have resulted from the change from the inner removal area to the outer removal area, which resulted in greater connection of flow between the river and the contained area.

10. It is not known whether the use of sheet pile walls would have resulted in less short-term impacts to the river than the silt curtain system. While likely controlling water quality exceedances during the dredging due to superior containment, there is potential that installation and removal of the sheet pile walls would have resulted in substantial releases. As observed throughout the GASCO project, several areas of the tar body exhibited highly mobile features and released substantial sheen at even the

slightest disturbance. Further analysis would be required to fully understand the potential for water quality issues and sediment resuspension during sheet pile installation and removal. However, sheet pile containment may be a viable option for future projects, specifically for longer-term projects where the financial and logistical issues may be lessened.

11. The hydraulic dredging alternative was not considered sufficiently by NW Natural, which cited concerns with the physical condition of the tar body and other issues. It is recommended that hydraulic dredging should be considered with any future dredging projects at GASCO or other Portland Harbor sites. The significant advantages of hydraulic dredging to control potential water quality impacts may outweigh disadvantages due to financial or logistical concerns. In addition, the use of hydraulic dredging may significantly reduce the necessity of containment structures. Future dredging projects should re-evaluate this alternative, including the use of pilot tests or other means to more fully evaluate the alternative.

12. It is not known if the non-aqueous phase liquids (NAPL) observed along the shoreline cut of the removal action area is present further into the river sediment. A relatively large area of NAPL has been documented in the upland portion of the GASCO site, but has not been directly linked to in-water areas, primarily due to lack of sufficient data. The lack of observed NAPL during the tar body characterization may be associated with the sampling method or the relatively limited cores completed. The presence of NAPL, and the potential connection with the upland area should be further investigated.

13. The water quality modeling using the Kuo-Hayes model did a poor job of predicting concentrations of contaminants away from the dredge. The actual concentrations detected outside the containment area were substantially higher than those predicted, even though the model assumed that no containment would be placed. The lack of model and field correlation may be due to the presence of NAPL, insufficient number or representativeness of dredge elutriate test (DRET) samples collected, and/or deficiency in the Kuo-Hayes model to incorporate high concentrations of contaminants. Calibrating the model with actual field data may be appropriate for future actions. However, alternative models should be explored and evaluated for applicability. Based on a preliminary review, no calibrated and accepted water quality models have been identified which incorporate dredging operations with a containment component. It should be noted that pilot tests are likely to be more reliable than modeled data.

14. A total of 12 dead fish were retrieved from the primary containment area during the removal action, including one adult Coho salmon and eleven adult or juvenile non-threatened and endangered fish. No dead and/or distressed fish were observed within the outer containment area or outside the containment area during the project. The fish take was consistent with that expected in the Biological Opinion. A total of 175 fish had been removed from the site through seining prior to the removal action. Considering that 12 dead fish (some very small) were discovered during the project, the ratio of fish removed to those potentially missed suggests that the seining was a very effective means of removing fish within the containment area, specifically considering that depths of greater than 20 feet were located in the removal areas.

15. The requirement for 72-hour laboratory analytical turnaround time and reporting to EPA was routinely not met during the project. The failure to report laboratory data in a timely manner was due to a combination of issues including, but not limited to, an

increase in the number of samples collected, very low detection limits required, and the lack of project-dedicated laboratory equipment and personnel. Timely laboratory data can be critical to implementing and evaluating best management practices. Future early actions, specifically those with chemical monitoring programs that require laboratory data to make field decisions, should include specific requirements and contingencies to ensure that the agreed-upon reporting is met consistently.

16. Sediment trap information was limited during the project and appears to be inconclusive, but appears to be a viable and important method for estimating downstream impacts of dredging. EPA will consider the use of sediment traps for future removal actions to evaluate the potential loss of contaminants during a removal action. However, because of the highly variable nature of the river system and the potential impacts of in-water work to affect natural scour and depositional areas, a relatively large system of sediment traps should be deployed to be an effective measurement tool. In addition, baseline conditions should be established over a relatively long period of time to account for seasonal fluctuations, as well as the impact of tidal influences.
17. The contaminants detected in a post-construction sample collected at the offloading facility at the Port of Morrow, appears to be related to the GASCO removal action. There is not sufficient data to estimate the area of extent, but based on site observations and known activities, it is expected to be limited. In addition, based on the lack of observations of direct spills, the diligent cleanup efforts of the contractor during the offloading activities, and the time which has passed since the occurrence (11 months) and continued use of the facility by others, further evaluation or cleanup of the offloading facility does not appear to be warranted. Future removal actions should consider the importance of collecting baseline and post-construction samples from offloading facilities and/or haul routes to assess potential impacts from site activities. A statistically representative number of samples should be collected to evaluate the need for and scope of post-construction remedial actions for contaminants tracked off-site or spilled.

5. REFERENCES

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TABLES

Table 1 **Concentration of Benzo(a)pyrene Inside and Outside Silt Curtain GASCO Early Removal Action**

Activity	Sample Date	Benzo(a)pyrene Conc. (ug/L)		Efficiency %
		Inside Curtain	Outside Curtain	
Dredging Inner Area	9/27/2005	16.6	0.328	98.0
	9/29/2005	16	0.36	97.8
	9/30/2005	11	0.11	99.0
	10/3/2005	9.9	3.3	66.7
	10/4/2005	4.4	0.62	85.9
	10/6/2005	2.2	1.4	36.4
	Average	**10.0**	**1.0**	**80.6**
Dredging Outer Area	10/11/2005	0.67	0.14	79.1
	10/12/2005	1	0.57	43.0
	10/13/2005	1.3	0.2	84.6
	10/14/2005	0.49	0.22	55.1
	10/15/2005	0.39	0.2	48.7
	10/16/2005	0.1	0.13	-30.0
	10/17/2005	0.13	0.33	-153.8
	10/18/2005	0.81	0.14	82.7
	Average	**0.6**	**0.2**	**26.2**
Capping	10/20/2005	0.31	0.081	73.9
	10/21/2005	0.24	0.35	-45.8
	10/22/2005	0.34	0.26	23.5
	Average	**0.3**	**0.2**	**17.2**

Table 2 **Concentrations of Benzo(a)anthracene and Benzo(a)pyrene Detected at 600 feet Downstream Location GASCO Early Removal Action**

DATE	Bottom Sample		Middle Sample		Surface Sample	
	benzo(a)anthracene	benzo(a)pyrene	benzo(a)anthracene	benzo(a)pyrene	benzo(a)anthracene	benzo(a)pyrene
10/12/2005	0.56	0.74	0.58	0.86	0.55	0.64
10/13/2005	0.019 UJ	0.019 U	0.12	0.22	0.14	0.23
10/14/2005	0.062	0.14	0.11	0.21	0.049	0.13
10/15/2005	0.05	0.61 J	0.069	0.14	0.13	0.2
10/16/2005	0.39	0.43	0.19	0.21	0.079	0.09
10/17/2005	0.51 J	0.45	0.18 J	0.19	0.074 J	0.02 U
10/18/2005	0.44	0.54	0.22	0.33	0.33	0.47
10/20/2005	0.28 J	0.32 J	0.11 J	0.26 J	0.032 J	0.034 J
10/21/2005	0.15 J	0.19 J	0.15 J	0.18 J	0.069 J	0.089 J
10/22/2005	0.02 UJ	0.027 J	0.02 UJ	0.027 J	0.019 UJ	0.02 J
10/24/2005	0.11 J	0.14 J	0.073 J	0.093 J	0.019 J	0.02 J
10/25/2005	0.099 J	0.11 J	0.12 J	0.15 J	0.052 J	0.044 J
10/27/2005	0.019 UJ	0.019 UJ	0.02 UJ	0.02 UJ	0.019 UJ	0.019 UJ
10/28/2005	0.041	0.043 J	0.02 UJ	0.02 UJ	0.021 UJ	0.021 U
10/29/2005	0.019 UJ	0.019 U	0.019 U	0.019 U	0.068	0.076

Notes:
U - Non-detect
J - Estimated, the result is below the reporting limit and above the laboratory detection limit.

Table 3 **Evaluation of Laboratory Data Reporting to EPA**
GASCO Early Removal Action

Date Sampled	Date Delivered to Lab	Lab Analysis Date[1]	Results Reported to EPA	Elasped Time (Days)
9/7/2005	9/8/2005	9/12/2005	9/14/2005	7
9/8/2005	9/9/2005	9/13/2005	9/14/2005	6
9/9/2005	9/12/2005	9/13/2005	9/15/2005	6
9/12/2005	9/13/2005	9/15/2005	9/16/2005	4
9/13/2005	9/15/2005	9/16/2005	9/19/2005	6
9/16/2005	9/19/2005	9/21/2005	9/22/2005	6
9/19/2005	9/21/2005	9/22/2005	9/23/2005	4
9/20/2005	9/21/2005	9/22/2005	9/23/2005	3
9/21/2005	9/21/2005	9/26/2005	9/27/2005	6
9/23/2005	9/26/2005	9/28/2005	9/28/2005	5
9/26/2005	9/27/2005	9/29/2005	10/4/2005	8
9/27/2005	9/28/2005	9/30/2005	10/4/2005	7
9/29/2005	9/30/2005	10/9/2005	10/11/2005	12
9/30/2005	10/3/2005	10/12/2005	10/13/2005	13
10/3/2005	10/4/2005	10/12/2005	10/17/2005	14
10/4/2005	10/5/2005	10/12/2005	10/17/2005	13
10/5/2005	10/6/2005	10/14/2005	10/17/2005	12
10/6/2005	10/7/2005	10/20/2005	10/21/2005	15
10/7/2005	10/8/2005	10/14/2005	10/21/2005	14
10/10/2005	10/11/2005	10/14/2005	10/21/2005	11
10/11/2005	10/14/2005	10/17/2005	10/26/2005	15
10/12/2005	10/13/2005	10/18/2005	10/26/2005	14
10/13/2005	10/14/2005	10/24/2005	10/26/2005	13
10/14/2005	10/17/2005	10/25/2005	10/28/2005	14
10/15/2005	10/18/2005	10/26/2005	10/28/2005	13
10/16/2005	10/18/2005	10/27/2005	11/1/2005	16
10/17/2005	10/18/2005	10/27/2005	11/1/2005	15
			Average	**10**

Notes:
Water Quality Certification requires a 72-hour reporting period by laboratory
[1] Date analyzed by lab may include multiple dates; date selected is latest date for 8270C Method

Table 4 Barge Water Treatment System Analytical Results GASCO Early Removal Action

Date	Concentration (ug/L)						
	Benzo(a)anthracene				Benzo(a)pyrene		
	Influent	Effluent	Percent Reduction		Influent	Effluent	Percent Reduction
9/19/2005	80.6	2.07	97.4%		132	3.47	97.4%
9/20/2005	2540	11.2	99.6%		2970	12.5	99.6%
9/21/2005	1.84	1.88	-2.2%		2.75	2.82	-2.5%
9/23/2005	7.8	6.9	11.5%		10.2	9.26	9.2%
9/26/2005	28.4	16.1	43.3%		80.4	72.7	9.6%
9/27/2005	31.9	12.5	60.8%		87.3	67.9	22.2%
9/28/2005	22	4.7	78.6%		27	5.5	79.6%
9/29/2005	24	2.7	88.8%		36	3.8	89.4%
9/30/2005	0.37	3.7	-900.0%		0.6	6.7	-1016.7%
10/1/2005	12	3.6	70.0%		14	5.9	57.9%
10/3/2005	330	25	92.4%		390	32	91.8%
10/4/2005	58	5.2	91.0%		78	6.1	92.2%
10/5/2005	49	3.7	92.4%		62	5.2	91.6%
10/6/2005	74	49	33.8%		110	70	36.4%
10/7/2005	9.1	76	-735.2%		15	100	-566.7%
10/10/2005	10	2.3	77.0%		20	4.2	79.0%
10/12/2005	31	2.6	91.6%		33	4.3	87.0%
10/13/2005	35	11	68.6%		35	15	57.1%
10/14/2005	73	13	82.2%		84	17	79.8%
10/15/2005	57	1.3	97.7%		61	1.7	97.2%
10/16/2005	210	40	81.0%		230	59	74.3%
10/17/2005	120	42	65.0%		95	60	36.8%
10/18/2005	380	1.7	99.6%		440	2.7	99.4%
10/19/2005	15	1.9	87.3%		14	2.8	80.0%

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FIGURES

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APPENDIX A

Field Notes

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APPENDIX B

Daily E-Mail Project Updates

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APPENDIX C

Photographic Documentation
Refer to folder on CD

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APPENDIX D

Supporting Information